

DEVICE AND METHOD
FOR PROTECTION
OF HEATING VENTILATION AND AIR CONDITIONING CONTROL CIRCUITS
FROM OVERCURRENTS

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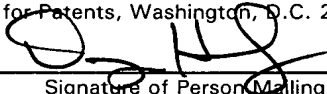
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FIELD OF THE INVENTION:

This invention relates generally to overcurrent protection for electrical circuits.

10 Specifically, this invention relates to positive temperature coefficient (PTC) overcurrent protection for heating, ventilation, and air conditioning (HVAC) control circuits.

BACKGROUND INFORMATION:

15 Circuit protection devices in HVAC control applications are well known. HVAC control circuits contain elements which may be harmed by overcurrents. Conventional fuses were developed to protect such elements by creating an open circuit in response to an overcurrent, but suffer from the drawback of being single-use devices. Once an open circuit is created in the fuse element, the fuse must be replaced. This deficiency was addressed with the invention of conventional circuit breakers. However, circuit breakers typically must be manually reset
20 after "tripping"; where "tripping" is defined as creating an open circuit or limiting the current in the circuit to a minimal, non-damaging value. Both fuses and circuit breakers are oftentimes located in places which are difficult or dangerous for service personnel to access. Additionally, circuit breakers are prone to failure modes typically associated with mechanical devices. Further, circuit breakers are typically bulky items compared to fuses.

25 PTC materials, specifically polymer-based PTC materials, exhibit characteristics which offer advantages over both conventional fuses and circuit breakers. PTC materials behave such that a steady state trip current, I_{trip} , through PTC material which will cause the material to "trip" can be chosen to be less than the maximum current carrying capacity, I_{max} , of an HVAC control circuit to be protected and greater than a combined load current, I_{load} , drawn by all loads

in the HVAC control circuit; where I_{max} is greater than I_{load} . Similar characteristics can generally be found in both fuses and circuit breakers.

Upon encountering a current greater than I_{trip} , the resistance of PTC material increases to limit current to a steady-state value that can be chosen to be substantially lower than I_{trip} , I_{load} , or I_{max} . Unlike fuses or circuit breakers, removal of conditions which caused the PTC material to "trip" causes the material to return to a state allowing currents up to I_{trip} to be conducted. Unlike fuse material, PTC material may be reused. Unlike circuit breakers, a PTC material-based device does not require service personnel or the user to access the device to reset it. PTC materials sufficient to provide overcurrent protection in HVAC control circuits are typically much less bulky than comparable circuit breakers. Current state of the art includes PTC materials which have a voltage rating commensurate with that required by HVAC control circuits.

Therefore, in view of the need for multi-use, non-bulky, HVAC control circuit overcurrent protection which can be reset without the user having access to the device and the potential benefits to be enjoyed in addressing the drawbacks of conventional circuit protection devices used in HVAC control circuits, the present invention has been designed and developed.

SUMMARY OF THE INVENTION:

The present invention includes features and components that have been invented and selected for their individual and combined benefits and superior performance. The invention includes a circuit protection device for protecting an HVAC control circuits from overcurrents and methods for employing the circuit protection device.

Each of the several embodiments of the invention described herein includes a PTC member. In addition, each of several embodiments described herein includes a pair of connective members, arranged so that the PTC member is disposed therebetween and in electrical contact therewith. The connective members provide the necessary external electrical interface for the circuit protection device. Each embodiment also includes a protective member

covering portions of the PTC member and the connective members. The protective member is chosen or constructed to insulate a user from contact with electrical hazard when the circuit protection device is installed. The same protective member is also designed to shield the circuit protection device from electrical and physical contact which would affect its performance or the performance of the HVAC control circuit within which it is included.

In one alternative embodiment, the connective members are configured as a pair of substantially parallel coplanar blades electrically and mechanically compatible with common blade-type fuse receptacles found in HVAC control circuits. In a further alternative embodiment, the connective members are configured as a pair of end caps at opposite ends of an insulating protective member to be electrically and mechanically compatible with common cartridge-type fuse receptacles commonly found in HVAC control circuits. In yet another alternative embodiment, the invention includes connective members configured as a pair of insulated lead wires of sufficient length to allow a tradesman skilled in the art to splice the circuit protection device into an HVAC control circuit to be protected. In yet another alternative embodiment of the present invention, the connective members and the protective member are collectively configured to be electrically and mechanically compatible with common screw-type fuse receptacles found in HVAC control circuits.

The invention also includes four methods for protecting an HVAC control circuit from overcurrents. These methods generally consist of the steps of (1) providing a circuit protection device of the present invention and (2) installing the device in the circuit to be protected in a fashion appropriate to its construction.

DESCRIPTION OF THE DRAWINGS AND ILLUSTRATIVE PHOTOGRAPHS:

Figure 1 is an exploded perspective view of a preferred embodiment of the present invention configured to be electrically and mechanically compatible with common blade-type fuse receptacles found in HVAC control circuits.

Figure 2 is a front elevational view of a preferred embodiment of the present invention configured to be electrically and mechanically compatible with common blade-type fuse receptacles found in HVAC control circuits.

Figure 3 is a side elevational view of a preferred embodiment of the present invention configured to be electrically and mechanically compatible with common blade-type fuse receptacles found in HVAC control circuits.

Figure 4 is a perspective view of an alternative embodiment of the present invention configured to be electrically and mechanically compatible with common cartridge-type fuse receptacles found in HVAC control circuits.

Figure 5 is a front elevational view of an alternative embodiment of the present invention configured to be electrically and mechanically compatible with common cartridge-type fuse receptacles found in HVAC control circuits.

Figure 6 is a side elevational view of an alternative embodiment of the present invention configured to be electrically and mechanically compatible with common cartridge-type fuse receptacles found in HVAC control circuits.

Figure 7 is a perspective view of an alternative embodiment of the present invention configured to be electrically and mechanically compatible with common screw-type fuse receptacles found in HVAC control circuits.

Figure 8 is an elevational view of an alternative embodiment of the present invention configured to be electrically and mechanically compatible with common screw-type fuse receptacles found in HVAC control circuits.

Figure 9 is an elevational view of an alternative embodiment of the present invention where the connective members are insulated wires of sufficient length to allow a tradesman skilled in the art to splice the circuit protection device into an HVAC control circuit.

DESCRIPTION OF THE INVENTION:

Based on the description and illustrations provided herein, the many benefits provided by the invented structure and methods of utilization are apparent. These described benefits, as well as those that are inherent to those skilled in the art, fall within the scope of the invention of the present patent application as limited only by the claims appended hereto.

Referring to Figures 1 - 9, each alternative embodiment of the HVAC control circuit protection device 100, 200, 300, 400 consists of a PTC member 110, 210, 310, 410; a pair of connective members 120, 130, 220, 230, 320, 330, 420, 430 and a protective member 140, 240, 340, 440. In each embodiment of the device 100, 200, 300, 400 described herein, the PTC member 110, 210, 310, 410 is radially leaded and disposed electrically between pairs of connective members 120 & 130, 220 & 230, 320 & 330, 420 & 430. Further, in each embodiment of the device 100, 200, 300, 400 described herein, the protective member 140, 240, 340, 440 serves to protect a user from contact with electrical hazard when the device 100, 200, 300, 400 is installed and to protect the device 100, 200, 300, 400 from electrical and mechanical hazard which would affect its performance or the performance of the HVAC control circuit to be protected.

Referring to Figures 1 - 3, a preferred embodiment of the HVAC control circuit protection device 100 is shown. Here, the PTC member 110 is disposed electrically between a pair of substantially co-planar and substantially parallel connective members 120, 130. The connective members 120, 130 provide the external electrical interface of the HVAC control circuit protection device 100 and are formed and arranged to be electrically and mechanically compatible with blade-type fuse receptacles commonly found in HVAC control circuits. The non-conductive protective member 140 of this embodiment is formed by two substantially similar halves which are joined to substantially cover the PTC member 110 and partially cover the connective members 120, 130. In addition, the protective member 140 contributes to the structural integrity of the device 100 through a plurality of posts 142 and recesses 144 which mate through a plurality of holes 125 in the connective members 120, 130.

Referring to Figures 4 - 6, an alternative embodiment of the present invention is shown.

In this embodiment, the connective members 220, 230 are conductive end caps disposed at opposite ends of a nonconductive protective member 240. The non-conductive protective member 240 substantially covers the PTC member's 210 conductive leads 212, 213 which connect electrically to the end caps 220, 230. The entire device 200 is electrically and mechanically compatible with cartridge-type fuse receptacles commonly found in HVAC control circuits.

Referring to Figures 7 and 8, a further alternative embodiment of the present invention is shown. In this embodiment, one connective member 320 is formed and disposed as the base of a screw-type circuit protection device commonly found in HVAC control circuits. The other connective member 330 is formed and disposed as the threads of such a screw-type circuit protection device. The non-conductive protective member 340 of the device 300 covers the PTC member 310 and supports and electrically isolates the connective members 320, 330. The entire device 300 is electrically and mechanically compatible with screw-type fuse receptacles commonly used in HVAC control circuits.

Referring to Figure 9, a further alternative embodiment of the present invention is shown. In this embodiment of the device 400, each of the connective members 420, 430 is an insulated conductor of sufficient length to allow a tradesman skilled in the art to splice the device 400 into an HVAC control circuit. The protective member 440 is configured as insulating heat shrink tubing or electrical tape to cover the PTC member's leads and the junction between the PTC member 410 and the connective members 420, 430.